

# **Geology and genesis of the Ridgeway porphyry Au-Cu deposit, NSW**

by

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Submitted in fulfilment of the requirements for the degree of

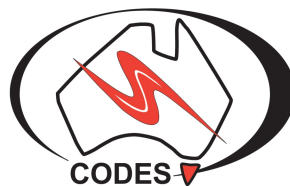
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# Abstract

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The Ridgeway alkalic porphyry Au–Cu deposit is located in the Molong Volcanic Belt of the Macquarie Arc, part of the Lachlan Fold Belt in eastern Australia. Ridgeway is hosted by a Middle Ordovician sequence of volcano-sedimentary rocks that were deposited in an active submarine sedimentary basin. The volcanic sequence evolved from fine grained distal volcanoclastics (Weemalla Formation) to coarse proximal breccias and sandstones (Forest Reef Volcanics). The host sequence was intruded first by pyroxene- and feldspar-phyric dikes and sills, and then by the Ridgeway intrusive complex, a cluster of subvertical porphyry pipes, dikes and stocks of monzodiorite (U–Pb<sub>zircon</sub> age:  $448.2 \pm 2.1$  Ma), mafic monzonite and quartz monzonite (U–Pb<sub>zircon</sub> age:  $444.2 \pm 1.3$  Ma). Cross-sectional shapes of the monzonite intrusions are broadly pipe-like. They swell at the contact between the Weemalla Formation and Forest Reef Volcanics.

The highest Au–Cu grades at Ridgeway are associated with quartz–magnetite–bornite vein stockworks and intense K-silicate alteration that formed during the emplacement of the mafic monzonite. These early stage veins have been truncated by the quartz monzonite porphyry and its lower grade quartz–chalcopyrite  $\pm$  molybdenite veins (Re–Os<sub>molybdenite</sub>:  $445.7 \pm 2.8$  Ma,  $442.8 \pm 2.3$  Ma) associated with less intense K-silicate alteration. A late-stage quartz monzonite cut the earlier phases, and defines the low-grade core of the deposit.

The mafic monzonite and quartz monzonite contain magnetite- and quartz-rich unidirectional solidification textures (USTs), miarolitic cavities and aplite vein-dikes. These textural features imply that magmatic-hydrothermal fluids streamed through and accumulated within the narrow pipes, which acted as a conduit to supply fluids from a deeper magma to the site of ore deposition. Mineralizing fluids were released when the carapace of the crystallizing fluids failed, and were emplaced preferentially into two subvertical vein systems that formed via hydraulic fracturing.

The older veins (set 2) strike N, WNW and NE, whereas the younger mineralized structures (set 3) strike E, NE and NW.

Cathodoluminescence imaging of quartz shows that most of the quartz (Qz-1) crystallized early in the history of vein formation. Dissolution of Qz-1 was then followed by the deposition of a second quartz generation (Qz-2). Cu–Fe sulfides were then deposited together with a later generation of darkly-luminescent quartz (Qz-3). Bright luminescence in Qz-1 correlates with elevated Al, Ti and K concentrations, whereas dull-luminescent Qz-3 is comparatively rich in Fe. High-temperature Qz-1 precipitated during vein stockwork formation at temperatures between 601° and 850°C in equilibrium with hydrothermal K-feldspar. Changes in pressure and temperature occurred during mechanical fracturing that created secondary permeability exploited by Qz-2. Further decrease in pressure and/or temperature facilitated the precipitation of Qz-3 at temperatures below 589°C, synchronous with Fe–Cu sulfides.

Sulfur isotopic compositions of sulfides from Ridgeway show increasing  $\delta^{34}\text{S}$  depletion in the sequence of pyrite (ave. -1.8 ‰), chalcopyrite (ave. -3.6 ‰) and bornite (ave. -4.9 ‰). Low  $\delta^{34}\text{S}_{\text{bornite}}$  and  $\delta^{34}\text{S}_{\text{chalcopyrite}}$  values occur in the core of the deposit. Isotopically light  $\delta^{34}\text{S}_{\text{pyrite}}$  values are also found in the core of the deposit, but these become more negative towards the top of the deposit, in the epidote–chlorite–hematite alteration zone. This is consistent with isotopic fractionation caused by cooling of the magmatic-hydrothermal fluids under oxidizing conditions during late-stage pyrite deposition.

The Ridgeway deposit was localized at the intersection of NW-trending faults and a NNW-trending monocline. The pre-existing NW-trending parallel wedge-shape faults provided the pathways for the deep-seated magma to migrate into the shallow crust. Roof-lifting within the fault wedge provided space for monzonite emplacement. At Ridgeway, there was an intimate link between magmatism and a dynamic structural environment that ultimately controlled the genesis of the high-grade orebody and provided an excellent focus for fluid flow in a well-developed vein stockwork.

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# Table of Contents

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<b>Abstract .....</b>	<b>i</b>
<b>Acknowledgements .....</b>	<b>iii</b>
<b>Table of Contents.....</b>	<b>v</b>
<b>List of Figures.....</b>	<b>xi</b>
<b>List of Tables.....</b>	<b>xii</b>
<b>List of Appendices.....</b>	<b>xvii</b>
<b>List of Abbreviations.....</b>	<b>xix</b>

## **Chapter 1: Introduction**

1.1. Preamble.....	1
1.2. Projects aims and objectives.....	5
1.3. Methodology.....	6
1.4. Thesis Organization.....	7
1.5. Cadia District - Exploration and mining history.....	8
1.5.1. Ridgeway Au–Cu porphyry deposit.....	10
1.6. Previous research.....	12

## **Chapter 2: Regional Geology**

2.1 Introduction.....	15
2.2 Tasman Fold Belt.....	15
2.3 Lachlan Fold Belt (Lachlan Orogen).....	17
2.4 Deformation in the Lachlan Fold Belt.....	20
2.5 Macquarie Arc.....	22
2.6 Crustal-scale structures and metallogeny of the Macquarie Arc.....	28
2.6.1 Lachlan Transverse Zone.....	29
2.7 Metallogeny in the Macquarie Arc.....	31

## **Chapter 3: Geology, Geochronology and Geochemistry**

3.1 Introduction.....	35
3.2 District Geology.....	35
3.3 Ridgeway Geology.....	37
3.3.1 Weemalla Formation.....	38
3.3.1.1 Feldspathic sandstone and siltstone.....	52
3.3.1.2 Calcareous sandstone and siltstone.....	52

3.3.1.3	Laminated and siliceous siltstone.....	52
3.3.2	Transitional unit.....	53
3.3.3	Forest Reefs Volcanics .....	53
3.3.3.1	Polymictic volcaniclastic lithic conglomerate and breccia.....	54
3.3.3.2	Monomictic volcanic breccia.....	58
3.3.3.3	Massive feldspathic sandstone and siltstone.....	58
3.3.3.4	Pyroxene-phyric and feldspar-phyric intrusions.....	59
3.4	Ridgeway intrusive complex.....	63
3.4.1	Pre-mineralization intrusion.....	65
3.4.1.1	Monzodiorite.....	65
3.4.2	Syn-mineralization intrusions.....	68
3.4.2.1	Mafic monzonite porphyry.....	68
3.4.2.2	Quartz monzonite porphyry.....	71
3.4.3	Late stage intrusion.....	75
3.4.3.1	Late-stage quartz monzonite.....	75
3.5	Mafic xenoliths.....	78
3.6	Tertiary Basalt.....	79
3.7	U–Pb Geochronology.....	79
3.7.1	Ridgeway $^{206}\text{Pb}/^{238}\text{U}$ geochronology.....	80
3.8	Igneous Geochemistry.....	82
3.8.1	Hydrothermal alteration effects and element mobility.....	83
3.8.2	Major element geochemistry.....	84
3.8.3	Trace and rare earth elements geochemistry.....	89
3.8.4	Comparison to Northparkes district.....	96
3.9	Discussion.....	96
3.9.1	Deposition of the Ridgeway host rocks.....	96
3.9.2	Ridgeway intrusive complex.....	97
3.9.3	Timing and nature of magmatism.....	100
3.10	Summary.....	101

#### **Chapter 4: Alteration and Mineralization**

4.1	Introduction.....	103
4.2	Previous work.....	105
4.3	Ridgeway vein paragenesis.....	106
4.3.1	Pre-main mineralization veins - Stage 1.....	114
4.3.1.1	Stage 1A Magnetite veinlets.....	114
4.3.1.2	Stage 1B Actinolite–magnetite veins.....	115



4.3.2	Main mineralization stage veins - Stage 2.....	116
4.3.2.1	Stage 2A Quartz–magnetite veins.....	117
4.3.2.2	Stage 2B Quartz–banded magnetite–bornite veins.....	117
4.3.2.3	Stage 2C Vein-dikes.....	120
4.3.2.4	Stage 2D Quartz–bornite veins.....	121
4.3.3	Main mineralization stage veins - Stage 3.....	121
4.3.3.1	Stage 3A Quartz–chalcopyrite veins.....	121
4.3.3.2	Stage 3B Vein-dikes.....	122
4.3.3.3	Stage 3C Chalcopyrite–epidote veins.....	122
4.3.3.4	Stage 3D Quartz ± chlorite veins.....	122
4.3.4	Late stage veins - Stage 4.....	127
4.3.4.1	Stage 4A Pyrite ± quartz veins.....	127
4.3.4.2	Stage 4B Epidote ± chlorite veins.....	127
4.3.4.3	Stage 4C Chlorite-rich matrix breccias.....	128
4.3.4.4	Stage 4D Calcite–prehnite ± quartz veins.....	129
4.4	Hydrothermal Alteration.....	129
4.4.1	Early alteration stage.....	132
4.4.1.1	Quartz ± albite alteration.....	132
4.4.1.2	Garnet–epidote alteration.....	137
4.4.1.3	Magnetite–actinolite–albite–biotite alteration.....	142
4.4.2	Main stage alteration.....	143
4.4.2.1	Orthoclase–biotite–albite–magnetite–actinolite alteration.....	143
4.4.3	Late stage alteration.....	149
4.4.3.1	Late orthoclase–albite alteration.....	149
4.4.3.2	Epidote–chlorite–hematite alteration.....	149
4.4.3.3	Hematite alteration.....	152
4.4.3.4	Outer propylitic alteration.....	152
4.4.3.5	Albite–quartz–pyrite–sericite alteration.....	153
4.4.4	Fault-related alteration.....	153
4.4.4.1	Clay–chlorite alteration.....	153
4.4.4.2	Epidote–hematite alteration.....	154
4.4.4.3	Carbonate alteration.....	154
4.5	Gold and copper grade distribution.....	154
4.6	Re–Os Geochronology.....	162
4.6.1	Re–Os Analytical Methods.....	162
4.6.2	Previous Re–Os geochronological studies.....	163

4.6.3	Results.....	163
4.7	Discussion.....	164
4.7.1	Pre-mineralization stage.....	164
4.7.2	Fluid evolution in space and time.....	165
4.7.3	K-silicate (Potassic) alteration and Au–Cu ore.....	166
4.7.4	Relationships between unidirectional solidification textures to Au–Cu mineralization.....	166
4.7.5	Ore distribution.....	169
4.7.6	Timing of the Magmatic - Hydrothermal System.....	170
4.8	Summary.....	173

## **Chapter 5: Structural Geology**

5.1	Introduction.....	175
5.2	Field Methods and Data Presentation.....	176
5.3	Previous Work.....	178
5.4	Structure of the Cadia district.....	179
5.4.1	Regional-scale structures.....	179
5.4.2	District-scale structures.....	180
5.5	Structures at Ridgeway.....	182
5.5.1	Folds.....	182
5.5.2	Faults.....	184
5.5.2.1	Northwest-striking, steeply-dipping faults.....	185
5.5.2.2	North-northwest striking, southwest-dipping reverse faults.....	189
5.5.2.3	Low-angle thrust faults.....	191
5.6	Geometry of veins and structures at Ridgeway.....	192
5.6.1	Domain Analysis.....	197
5.6.1.1	Vein set 1.....	197
5.6.1.2	Vein set 2.....	199
5.6.1.3	Vein set 3.....	201
5.6.1.4	Vein set 4.....	203
5.6.2	Comparison with pre-existing mine data.....	204
5.6.3	Dikes and sills.....	205
5.7	Structural level plans.....	206
5.7.1	5100mRL.....	206
5.7.2	5255mRL.....	207
5.7.3	5330mRL.....	209
5.8	Discussion and Summary.....	210

5.8.1	Deposit-scale structural interpretations.....	210
5.8.1.1	Pre-mineralization deformation.....	210
5.8.1.2	Mafic dikes as paleostress-direction indicator.....	210
5.8.2	Magma intrusion: a structural model.....	211
5.8.3	Vein formation, fluid pressure and differential stress.....	217
5.8.4	Structural History.....	218

## **Chapter 6: Hydrothermal Geochemistry**

6.1	Introduction.....	223
6.2	Cathodoluminescence.....	223
6.2.1	Methodology.....	224
6.2.2	Hydrothermal quartz vein textures.....	225
6.2.2.1	Qz-1A: euhedral growth zones.....	226
6.2.2.2	Qz-1B: diffuse zones.....	227
6.2.2.3	Qz-2: quartz overgrowths on dissolution surfaces.....	227
6.2.2.4	Qz-3: CL-dark luminescence.....	227
6.2.3	Electron microprobe results.....	228
6.2.3.1	Stage 2B quartz–banded magnetite–bornite veins.....	228
6.2.3.2	Stage 2D quartz–bornite vein.....	229
6.2.3.3	Stage 3A quartz–chalcopyrite vein.....	234
6.2.3.4	Stage 3D quartz vein.....	236
6.2.4	Titanium-in-quartz geothermometer.....	236
6.2.5	Discussion.....	239
6.2.5.1	Correlation between quartz types, CL intensity and trace elements...	239
6.2.5.2	Temperature of quartz formation and sulfide precipitation.....	241
6.3	Fluid Inclusions.....	241
6.3.1	Previous work.....	242
6.3.2	Methodology.....	243
6.3.3	Classification.....	243
6.3.4	Microthermometry results.....	244
6.3.5	Discussion.....	246
6.3.5.1	Pressure and depth estimates.....	246
6.4	Sulfur Isotopes.....	248
6.4.1	Previous Work.....	248
6.4.2	Methodology.....	248
6.4.3	Results.....	250
6.4.3.1	Stage 2B and 2D veins.....	250

6.4.3.2	Stage 3A and 3C veins.....	252
6.4.3.3	Stage 4A pyrite veins and disseminations.....	252
6.4.4	Discussion.....	257
6.4.4.1	Fluid and sulfur sources.....	257
6.5	Oxygen Isotopes.....	259
6.5.1	Previous work.....	260
6.5.2	Methodology.....	261
6.5.3	Results.....	261
6.5.4	Discussion.....	261
6.6	Summary.....	264

## **Chapter 7: Summary and Genetic Model**

7.1	Introduction.....	265
7.2	Volcano-sedimentary succession, magmatism and volcanic setting.....	265
7.3	Ridgeway genetic model.....	267
7.3.1	Structural controls and history of emplacement.....	267
7.3.2	Intrusions, alteration and mineralization.....	270
7.3.2.1	Pre-mineralization: monzodiorite, stage 1 veins and related hydrothermal alteration events.....	271
7.3.2.2	Main-stage mineralization: mafic monzonite porphyry, stage 2 veins and related hydrothermal alteration events.....	270
7.3.2.3	Main-stage mineralization: quartz monzonite porphyry, stage 3 veins and related hydrothermal alteration events.....	272
7.3.2.4	Late-stage: equigranular quartz monzonite, stage 4 veins and related hydrothermal events.....	273
7.3.2.5	Post-mineralization: fault-related hydrothermal alteration events.....	277
7.3.3	Timing of igneous activity and sulfide mineralization.....	278
7.3.4	Sulfide precipitation.....	279
7.3.5	Gold enrichment in the alkaline melts at Ridgeway.....	279
7.4	Exploration Implication.....	280
7.5	Further Work.....	281

<b>References.....</b>	<b>283</b>
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